GENESIS SEARCH FOR ORIGINS Education

Dynamic Design: A Collection Process

Parabolic Problem
Algebra Enrichment

TEACHER GUIDE

BACKGROUND

For students to be successful with this enrichment activity, they should have had previous experience with the following algebraic concepts: square roots, exponents, graphing on a Cartesian grid, the distance formula, and multiplying binomials.

A cross-section of the mirror grid in the Genesis solar wind concentrator is a parabola. A parabola is a curve consisting of all points equidistant from a line called the directrix and a point called the focus. One way to determine the equation of a parabola is to use the distance formula. In this mathematics enrichment activity, students determine the equation for a parabola and graph the parabola using measures similar to that of the Genesis concentrator. Students work backwards compared with the Genesis designers. In the mission, the designers worked to find the location of the focus from the parabolic shape of the concentrator. The focus on the Genesis concentrator is about 20 cm from the vertex of the parabola. In this problem the focus is given and the students will graph the resulting parabola.

NATIONAL MATH STANDARDS ADDRESSED

Grades 9-12

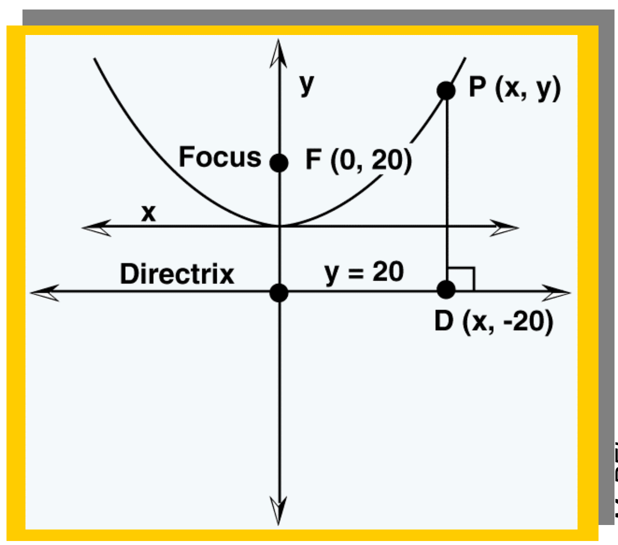
Mathematics Standard: Mathematics as Problem Solving

Apply integrated mathematical problem-solving strategies to solve problems from within and outside mathematics.
Apply the process of mathematical modeling to real-world problem situations.

Mathematics Standard: Functions

Model real-world phenomena with a variety of functions.
Represent and analyze relationships using tables, verbal rules, equations, and graphs.
Recognize that a variety of problem situations can be modeled by the same type of function.

(View a full text of the National Math Education Standards.)



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MATERIALS

- Graph paper
- Paper, pencil
- Pipe cleaners and clay
- Calculator (optional)

PROCEDURE

1. Set the scenario by reading the background information with students. Allow students to determine the distance between two points by using the distance formula or by other means. Let students explore to find out how to solve the problem. Below is one way to solve the first part.

2. The distance between two points can be determined by using the distance formula. If P_1 is (x_1, y_1) and P_2 is (x_2, y_2) then the distance between them is :

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

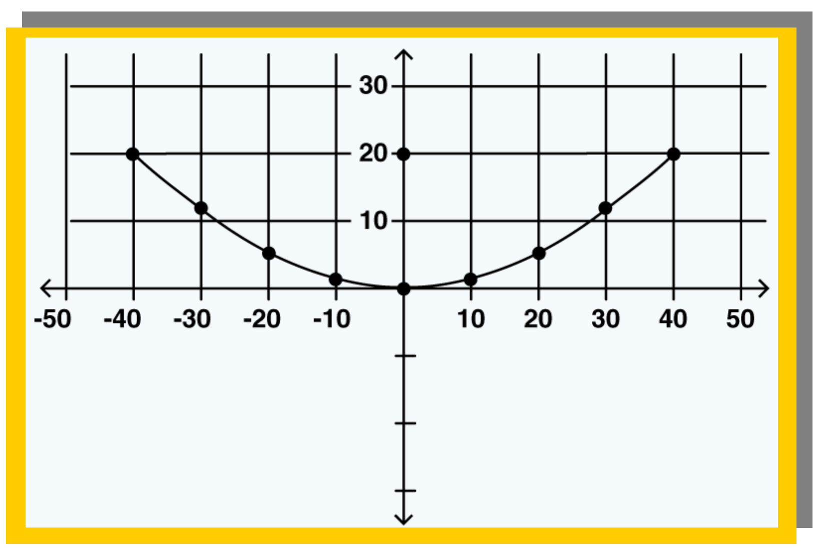
3. The target on the concentrator is about 20 centimeters from the vertex of the parabola. This can be stated as F(0,20), the directrix is y = -20, P (x,y) is any point on the parabola, and D (x,-20) is the point where the perpendicular line through point P to the directrix intersects the directrix. (See figure 1) Find the equation of the parabola.

Figure 1

Line A	$\overline{PF}$	=	$\overline{PD}$
Line B	$\sqrt{(x-0)^2+(y-20)^2}$	=	$\sqrt{(x-x)^2+(y--20)^2}$
Line C	$(x-0)^2+(y-20)^2$	=	$(x-x)^2+(y--20)^2$
Line D	$x^2+(y-20)^2$	=	$(y+20)^2$
Line E	$x^2+(y-20)(y-20)$	=	$(y+20)(y+20)$
Line F	$x^2+y^2-40y+400$	=	$y^2+40y+400$
Line G	x^2	=	$80y$
Line H	y	=	$x^2/80$

4. Using this information, graph the parabola: $y= x^2/ 80$. Encourage students to fill in the T-chart with values for several points (x,y) on the parabola that can be found.

x	y



5. Using pipe cleaners, make a model of the parabolic curve. Make the model three-dimensional by using three pipe cleaners bent to the shape of the parabola. (Join them at the vertex).

6. Use clay to make a three dimensional model of the paraboloid.

EXTENSION

With an understanding of calculus, students may:

1. Find the area under the curve.
2. Find the surface area of part of the paraboloid.
3. Find the volume of part of the paraboloid.